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(54) Tactile Stimulator with Improved Contact Surfaces

(72) Fraser, Richard K. - Canada ;

(71) Same as inventor

(30) (US) 08/317,566 1994/10/04

(57) 26 Claims

Notice: This application is as filed and may therefore contain an incomplete specification.



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ABSTRACT OF THE DISCLOSURE

5 A tactile stimulation apparatus produces signals
which are decoded to produce a programmed sequence of
output signals. The output signals are supplied to an
array of switches or actuators which are supported on a
seat, a bed-like structure, or an article such as a
helmet or garment. When the switches or actuators are
actuated, a contact surface member which is associated
with the actuated switch is driven to press against the
10 body. The programming of the signals is variable and
such as to induce a tactile stimulation of the body which
can be used for therapeutic purposes, the transmission of
information or the like.



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TACTILE STIMULATOR WITH IMPROVED CONTACT SURFACESBackground of the Invention

5 This invention relates to an improvement in a tactile stimulator having body-contacting switches. More particularly, this invention relates to an improved contact surface for the device described in the applicant's prior issued U.S. Patent No. 4,779,615. Still more particularly, this invention relates to an improved
10 article for implementing the features of this improvement and the invention of the '615 patent.

Description of the Related Art

15 A tactile stimulator having a variety of programmed sources for controlling body stimulation is described in the applicant's prior U.S. Patent No. 4,779,615, the disclosure of which is incorporated by reference. As described, an apparatus for practicing the method of the invention comprises an article which is structurally
20 adapted for receiving the body of its user in a comfortable position. A plurality of switches or actuators are located in a predetermined, spaced array and cooperate with a control device which respectively, repetitively, and sequentially actuate the switches according to a
25 programmed source. A number of different sources are described.

In the '615 patent, the plurality of switches comprise a switch portion and an actuated extensible portion which is operable to extend to a full or a
30 controllable distance to stimulate the body of a person using the article, such as a sofa having a seat portion and a back portion.

This invention relates to an improvement to the invention of that patent insofar as it relates to the
35 contact surface of the switch at its extensible portion, and the cooperation of such switches with articles which can be worn, or used to support part or all of the human body and which incorporate the switches.



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Brief Description of the Invention

This improvement relates to an apparatus for providing tactile stimulation of a body, of the type described in U.S. patent No. 4,779,616, the disclosure of which is incorporated by reference.

5 A first aspect of the invention resides in an apparatus which includes a source of signals having a predetermined characteristic; means for decoding the signals to produce a programmed sequence of operative output signals; an article structurally adapted for receiving at
10 least a portion of a body of a user in contact therewith, the article including a plurality of switches in a spaced array, each of said switches having an extendable portion which, when actuated, extends and presses directly
15 against the body of the user or is covered and moves an area of said article against a portion of the body of the user. The switches are connected to the decoding means to receive the operative output signals to be actuated thereby according to said programmed sequence, whereupon
20 the body is tactilely stimulated according to the sequence.

The article, in accordance with the first aspect comprises a support frame made from a plurality of laterally-extending, elongated members which define in
25 part a space for accommodating a flexible support mechanism. A plurality of tactile grid suspension cables are longitudinally disposed in said space for supporting a mounting flange for each switch. The switches may be linear motor, solenoid, transducer, piezoceramic, magnetostriction or servo-moving unit switches, activated by
30 signals from a suitable source. The switches may be operable by electrical, hydraulic, or pneumatic signals. The frame is covered by a suitable protective covering.

The switches or actuators according to this improvement of the invention include a movable shaft having a
35 ball joint at a distal end thereof for receiving a



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generally planar contact surface member which can incline in two degrees of freedom, while retraction or extension of the movable shaft provides movement in the third degree of freedom. A plurality of such contact surfaced members are arranged in an array with a minimal distance between them to improve the stimulation of the body.

5 A further important aspect of the invention resides in a communication apparatus for providing information in the form of tactile stimulation of a body, comprising: an article which is supported by a portion of a human body or which supports a portion of a human body; an actuator which disposed on the article in a manner which allows pressure to be selectively applied to the portion of the human body; and a source of activation signals which is
10 operatively connected with at least one actuator in a manner to supply an activation signal thereto.

Another important aspect of the invention resides in a communication apparatus for providing information in the form of tactile stimulation of a body, comprising: an article which can be placed in contact with a portion of the human body; an actuator disposed on the article in a manner which allows pressure to be transmitted between the actuator and the body, the actuator being arranged to at least one of output a signal indicative of the pressure being applied thereto by the body and apply a pressure to the body in response to an input signal; and means for transmitting signals between the actuator and a remote location.

25 These and other features of the invention will become apparent from the detailed description of the invention which follows, taken in conjunction with the accompanying drawings.



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Brief Description of the Drawings

Fig. 1 is a generalized depiction of a sofa-like article such as a hospital bed incorporating a plurality of programmed switches for contacting at least a portion of a body of a user;

Fig. 2 is an enlarged view of a portion of Fig. 1 enclosed in the circle II shown in Fig. 1;

Fig. 3 is a more detailed view of the article showing a support frame and a protective covering;

Fig. 4 is a fragmented, detailed view of a support mechanism for the switches in the support frame;

Fig. 5 is a side generalized view of several of the plurality of switches showing a ball joint on the movable shaft and a pivotable contact surface member, according to the invention;

Fig. 6 is a perspective view showing switches which each have a plurality of projectable shafts;

Fig. 7 is a side elevational view showing the manner in which a plurality of switches, having different types of contact surface members, can be arranged together;

Figs. 8 and 9 show a possible military type application wherein a tactile stimulator is disposed in a helmet and arranged to be responsive to predetermined types of signals indicative of danger or the like.

Detailed Description of the Invention:

In Fig. 1, an arrangement for implementing the features of the invention of the '615 patent and these improvements is shown in the form of a bed-like structure having a surface 12 for presenting a plurality of programmed switches 14 to a body 16 of a user. In the representative environment depicted, a physician 18 is manipulating a control panel 20 to manually actuate selected ones of the plurality of programmed switches 14. In the alternative, the switches can be programmed as described in the '615 patent.



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As seen in Fig. 2, the switches include a plurality of generally planar contact surface members 22 pivotally connected to a distal or upper end 24 of a reciprocally movable shaft 26 of each of the switches 14. The movable shaft 26, as seen in Fig. 2, can be extended to its full extensible distance, or to some portion thereof according to control signals provided from a remote signal source included in the control panel 20, by way of control lines generally denoted by the reference numeral 28. The movable shaft 26 is controlled by an actuator 30 such as a linear motor, a solenoid, transducer, piezoceramic, magnetostriction or a servo-moving unit, by way of example. The actuator 30 may be electrically, hydraulically, or pneumatically controlled. The contact surface members 22 are positioned adjacent one another in a grid or array "A" to cover substantially all of the surface of the array, with a minimum of distance between adjacent contact surface members 22. Such an array thus improves the area of stimulation of the user's body 16, such as a patient, compared to the switches or actuation devices depicted in the '615 patent.

As best seen in Fig. 5, the contact surface members 22 are connected to a ball joint 32 at the distal end of the movable shaft 26. Such a connection permits the contact surface members 22 to pivot about the end of the respective shafts 26 with two degrees of freedom, i.e. in the X and Y axes, while movement of the shaft permits movement in the Z axis. Other flexible connections or gimbals between the movable shaft 26 and the contact surface members 22 are also possible to achieve the same flexibility.

Fig. 3 shows a representative bed-like article or structure 10 in greater detail. The article 10 includes a support frame, shown generally at the reference numeral 40 having a plurality of support members 42 arranged in pairs at opposed sides of the article 10 and supported by



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intermediate support members 44. The support members 42 are separated by laterally extending cross members 46 arranged in pairs to form a frame-like structure with intermediate supporting members 48. Such a structure may be modular to form a foot-section 50 which is separated from a head section 52 and pivotable about an axis 54 relative to the head section 52. The respective frame-like structures form intermediate open spaces framed between the lateral and longitudinal members. A plurality of tactile grid suspension cables 58, which form part of a flexible support mechanism, extend between the members 42 to define resting supports for mounting flanges 60 of the actuators 30 which form part of the switches 14, to permit the grid or array of switches 14 to be easily assembled and configured.

Fig. 6 shows a switch variant wherein each of the actuators 30 are arranged to have a plurality (in this case two) of telescopically arranged shafts. As will be appreciated, the center shaft 26a is reciprocally disposed in main shaft 26b and arranged to be separately driven to extend out of the main shaft 26b. The center shaft 26a is, in this embodiment, provided with a domed tip so as to apply a point pressure. The main shaft 26b on the other hand, can be arranged to have a relatively flat upper end so as to apply a smaller force per unit area type pressure to the patient's body than that applied by the center shaft 26a. Alternatively, the upper ends of the main shafts 26b could be domed, provided with a concave recess, dimpled or the like, depending on the stimulation that is required. As a further alternative, a ridged pattern which simulates the effect of a human finger can be provided at the upper end of one or both of the shafts 26a, 26b.

With this arrangement, it is possible for the main shaft 26b to be raised with the center shaft 26a in a fully retracted position, for the center shaft 26a



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projected with the main shaft 26b in a fully retracted state, or any suitable combination of the two. This operation can be achieved by providing each of the shafts with its own servo mechanism, e.g. hydraulic or pneumatic chamber, solenoid, or the like. The shafts may be arranged to have a rectangular cross-section if so desired.

The embodiment of the invention shown in Fig. 7 features a combination of different actuators and contact surfaces. As will be appreciated, the switches or actuators 30a, 30b, 30c and 30d are arranged such that actuator 30a is provided with a relatively wide surface area contact surface member 22a which is provided with a resilient padded member on the upper surface, actuator 22b is provided with a contact surface member 22b which is provided with a plurality of resilient dimples on the upper surface, actuator 30c is of the type which includes a plurality of telescopically arranged shafts 26a, 26b, and actuator 30d is provided with a flat unpadded contact surface member 22d. The contact surface members 22a, 22b and 22d which are respectively provided at the tops of the actuators 30a, 30b, and 30d, have a square configuration of the nature depicted in Fig. 2, for example.

The actuators shown in Fig. 7 each have a mounting flange 60 so that the arrangement of the actuator matrix can be selectively adjusted simply by replacing one actuator with another. It is also within the scope of the invention to provide the shafts 26' on which the support members 22a, 22b, for example, are mounted, with a screw thread which allows the height of the support members to be adjusted in accordance with the type of arrangement provided atop of the respective support member, or in accordance with the stimulating effect that is required.

It will be appreciated that a cover be provided between the actuators and the person being stimulated by



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the devices. While the cover is optional it is possible that the cover be thin, so as maximise the tactile stimulation effect, or thick and sufficiently padded as to smooth the effect provided. The cover may also be provided simply for purposes of hygiene and take the form of a sheet which can be quickly and easily changed for each patient.

The present invention is not limited to therapeutic arrangements and can be used in connection with a number of different applications such as the transmission of information. It is possible to use the tactile stimulation which is possible with the present invention to transfer information. For example, while person remains in contact with the tactile stimulation devices, even if totally distracted, tactile stimulation can provide a critical communication link even in sudden or total darkness, and enable vital warnings and/or system status even during times of information overload. The particular facet of the invention finds military application inasmuch as it is possible to mount the tactile stimulating actuators in helmets, boots, or garments such as flight suits, vests or the like, in the manner illustrated in Figs. 8 and 9 so as to be able to enable information to be transmitted during the confusion and noise of battle, for example. It is within the scope of the present invention to include arrangements wherein a person could be sandwiched between front and back units or between top and bottom panels allowing stimulation simultaneously to the user's back and rear area, and to chest, stomach, front thighs and even face, etc.

Pilots who are faced with spatial disorientation and information overloads under combat conditions for example, could be supplied with information. A pilot could be literally "tapped on the shoulder" to bring his or her attention to approach of another aircraft on that particular side of his or her own aircraft. The IFF (Infor-



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nation Friend or Foe) program employed by the Pentagon could be well served through the implementation of such a tactile stimulation technique. An example of this type of application is shown in Figs. 8 and 9. As illustrated, in order to warn infantry soldiers that they are in the line of "friendly" fire, tactile stimulators can be disposed in the soldiers' helmets and arranged to be responsive to an emission from a remote source. This emission can take the form of an infra-red beam or the like, which is produced by a beacon provided on "friendly" weapons such as rifles and the like.

The "downward prod" produced by the stimulator would induce the recipient to duck down out of the line of fire and thus greatly enhance personal safety.

A further aspect of the invention resides in that the tactile units are not limited to applying pressure and can act as both transmitters as well as receivers. In one mode each device could act as a stimulation receiver wherein the user is tactually stimulated by the device. It could then be manually or automatically switched to allow the stimulation receiver devices act as transmitter devices allowing the user, through physical contact with the device, to send tactile stimulation messages. A two stage tactile device could be used in this way where the inner stage became the sender and the outer stage became the receiver of the stimulation-communication. This would allow mirror-like tactile patterns to be transmit to the hand or body of the other party. An example is a tactile communication pad which is integrated with a telephone. When one part placed their hand on the tactile communication pad when talking to a loved one by phone, tactile patterns could be sent and received in a mirror image-like manner allowing stimulated physical contact. With so much business travel many families experience at least some time apart.



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Such a device could be useful in maintaining closer family ties.

5 In the work place, programs of stimulation to provide motivation could be developed, allowing one at a workstation to receive tactile stimulation motivation during times when ones' productivity and motivation is low.

10 A more poignant use could be as a comforting device during mourning. This type of arrangement would allow one to leave a personal touch message to comfort their loved ones after they have passed on, to help them recover from their loss.

15 An educational facet of the invention is such that students could receive patterns of tactile imprinting stimulation on their bodies. For example, studies have shown that physical contact between the teacher and the student during the learning process accelerates the amount of material retained, and that replay of the stimulation can be used to induce recall of the learnt information.

20 An entertainment aspect of the invention comes in the application of the invention with virtual reality technology to permit a physical link which is currently lacking in this field, to be established.

25 It will clearly be understood by those skilled in the art that the invention is not limited to the specifically disclosed embodiments which have been described hereinabove and that various changes and modifications may be made without departing from the scope of the present invention which is to be limited only by the appended claims.



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WHAT IS CLAIMED IS:

- 1 1. An apparatus for providing tactile stimulation
2 of a body comprising:
3 a source of signals having a predetermined charac-
4 teristic;
5 means for decoding the signals to produce a pro-
6 grammed sequence of operative output signals;
7 an article structurally adapted for receiving at
8 least a portion of a body of a user in contact therewith,
9 the article including a plurality of switches in a spaced
10 array, each of said switches having an extendable portion
11 which, when actuated, extends and presses against a
12 portion of the body of the user;
13 wherein the switches are connected to the decoding
14 means to receive the operative output signals and to be
15 actuated in accordance with said programmed sequence,
16 whereupon the body is tactilely stimulated according to
17 the sequence, and
18 wherein the article comprises a support frame made
19 from a plurality of laterally-extending, elongated
20 members which define in part a space for accommodating a
21 flexible support mechanism which is used to support said
22 plurality of switches.
- 1 2. The apparatus as set forth in claim 1, further
2 comprising a plurality of tactile grid suspension cables
3 which are longitudinally disposed in said space for
4 supporting a mounting flange for each switch.
- 1 3. The apparatus as set forth in claim 1, wherein
2 the switches may include one of a linear motor, a
3 solenoid, and servo-moving unit switches, activated by
4 signals from said suitable source.



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1 4. The apparatus as set forth in claim 1, wherein
2 the switches may be operable by electrical, magnetostric-
3 tion, piezoceramic or hydraulic, or pneumatic signals.

1 5. The apparatus as set forth in claim 1, wherein
2 said plurality of switches each has a contact member
3 operatively connected therewith, said contact member
4 having a predetermined configuration and being arranged
5 to directly contact the body of the user.

1 6. The apparatus as set forth in claim 1, wherein
2 the frame is covered by a suitable protective covering.

1 7. An apparatus for providing tactile stimulation
2 of a body comprising:
3 a source of signals having a predetermined charac-
4 teristic;
5 means for decoding the signals to produce a pro-
6 grammed sequence of operative output signals;
7 an article structurally adapted for receiving at
8 least a portion of a body of a user in contact therewith,
9 the article including a plurality of switches in a spaced
10 array, each of said switches having an extendable portion
11 which, when actuated, extends and moves an area of said
12 article against a portion of the body of the user;
13 wherein the switches are connected to the decoding
14 means to receive the operative output signals to be
15 actuated thereby according to said programmed sequence,
16 whereupon the body is tactilely stimulated according to
17 the sequence, the switches respectively including a
18 movable shaft having a ball joint at a distal end thereof
19 for receiving a generally planar contact surface member
20 which can incline in two degrees of freedom, while
21 retraction or extension of the movable shaft provides
22 movement in the third degree of freedom.



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1 8. The apparatus as set forth in claim 7, further
2 including a plurality of such contact surface members
3 which are arranged in an array with a minimal distance
4 between them to improve the stimulation of the body of
5 the user of the apparatus.

1 9. An apparatus for providing tactile stimulation
2 of a body, comprising:
3 a frame;
4 an array of actuators supported on said frame in a
5 manner which allows each actuator to be selectively moved
6 from one position to another within said array, each of
7 said actuators having at least one member which can be
8 selectively induced to project therefrom; and
9 a source of programmed signals which is operatively
10 connected with said actuators in a manner to supply each
11 of said actuators with a signal.

1 10. An apparatus as set forth in claim 9, wherein
2 said actuators have two members which can be each induced
3 to selectively project out of said body.

1 11. An apparatus as set forth in claim 10, wherein
2 said actuators have a first member which is reciproca-
3 tively disposed in a second reciprocative member and
4 selectively projectable therefrom, said second member
5 being selectively projectable irrespective of whether
6 said first member is projected from said second member.

1 12. An apparatus as set forth in claim 9, wherein
2 said actuators each have an essentially flat rectangular
3 pressure surface member, said flat rectangular pressure
4 surface member being so dimensioned that in the array of
5 actuators, the flat pressure surface members mounted on
6 immediately adjacent actuators closely approximate one
7 another.



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1 13. An apparatus as set forth in claim 9, wherein a
2 first plurality of the actuators of said array are pro-
3 vided with a first type of pressure surface member and a
4 second plurality of the actuators of said array are
5 provided with a second type of pressure surface member,
6 said first and second types of pressure surface members
7 being arranged to apply pressure to a body supported on
8 said frame, said first and second pressure surface mem-
9 bers having different force applying characteristics.

1 14. An apparatus for providing tactile stimulation
2 of a body comprising:
3 a frame;
4 a plurality of wires tautly strung across said
5 frame;
6 an array of actuators supported on said wires, each
7 of said actuators having a body and at least one member
8 which can be selectively induced to project out of said
9 body;
10 a source of programmed signals which is operatively
11 connected with said actuators in a manner to supply each
12 of said actuators with a signal.

1 15. An apparatus as set forth in claim 14, wherein
2 each of said actuators has a pressure surface member
3 which is pressed against a body supported on said frame.

1 16. An apparatus as set forth in claim 15, wherein
2 pressure surface member can have any one of a plurality
3 of different configurations so that the force which is
4 applied to the body is selectively variable.

1 17. A communication apparatus for providing
2 information in the form of tactile stimulation of a body,
3 comprising:



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4 an article which is supported by a portion of a
5 human body or which supports a portion of a human body;
6 an actuator disposed on said article in a manner
7 which allows pressure to be selectively applied to the
8 portion of the human body; and
9 a source of activation signals which is operatively
10 connected with said at least one actuator in a manner to
11 supply an activation signal thereto.

1 18. A communication apparatus as set forth in claim
2 17, wherein said article comprises a helmet.

1 19. A communication apparatus as set forth in claim
2 17, wherein said article comprises a vest.

1 20. A communication apparatus as set forth in claim
2 17, wherein said article comprises a garment.

1 21. A communication apparatus as set forth in claim
2 17, wherein said article comprises a portion of a seat.

1 22. A communication apparatus for providing
2 information in the form of tactile stimulation of a body,
3 comprising:

4 an article which can be placed in contact with a
5 portion of the human body;

6 an actuator disposed on said article in a manner
7 which allows pressure to be transmitted between said
8 actuator and said body, said actuator being arranged to
9 at least one of output a signal indicative of the
10 pressure being applied thereto by said body and apply a
11 pressure to said body in response to an input signal; and
12 means for transmitting signals between said actuator
13 and a remote location.



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1 23. A communication apparatus as set forth in claim
2 22, wherein said article comprises a helmet.

1 24. A communication apparatus as set forth in claim
2 22, wherein said article comprises a vest.

1 25. A communication apparatus as set forth in claim
2 22, wherein said article comprises a garment.

1 26. A communication apparatus as set forth in claim
2 22, wherein said article comprises a portion of a seat.



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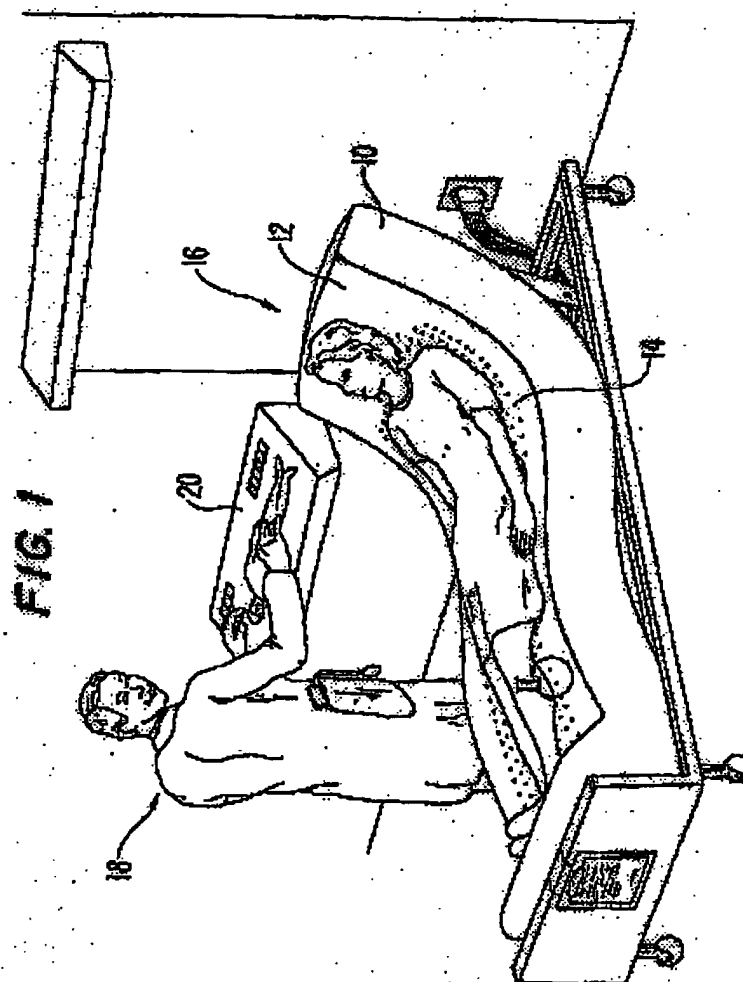


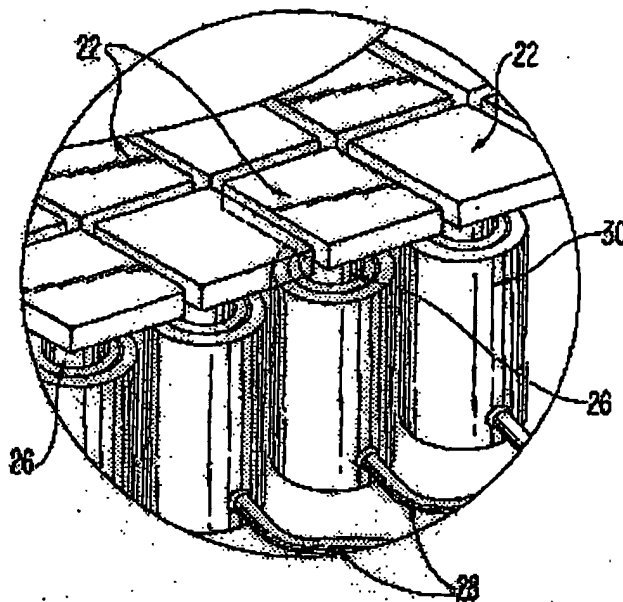
FIG. 1

Quilley, Smith & Henderson



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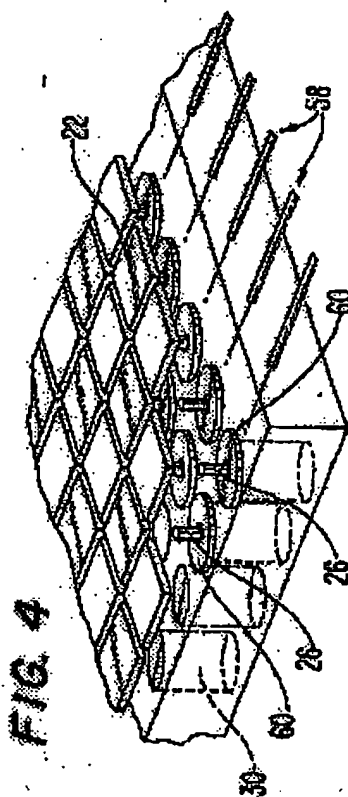
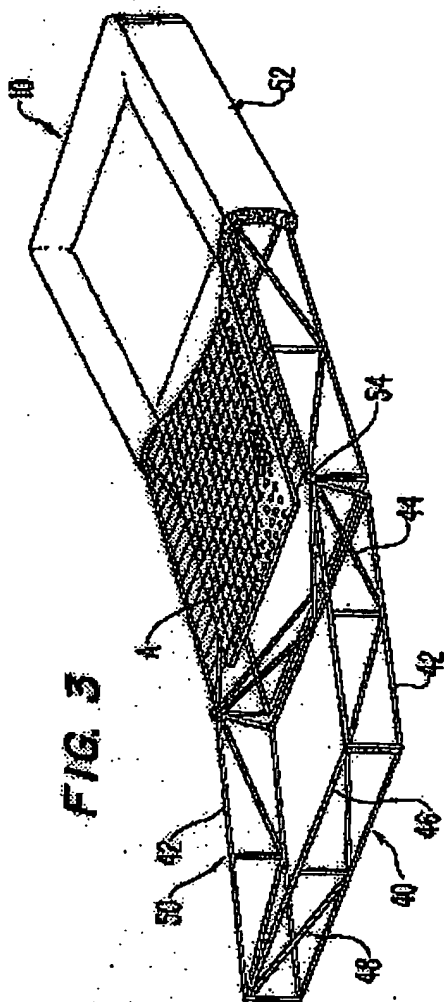
FIG. 2



Goulding, Strickley & Henderson



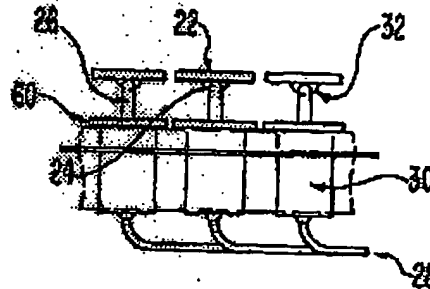
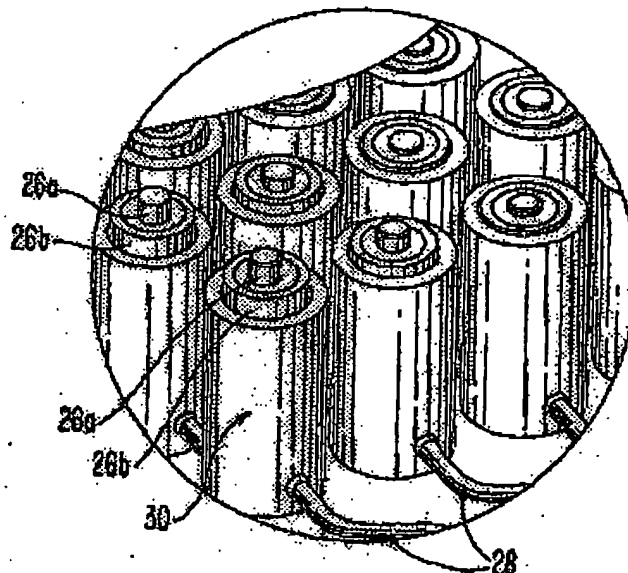
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Goulby, Smith & Anderson



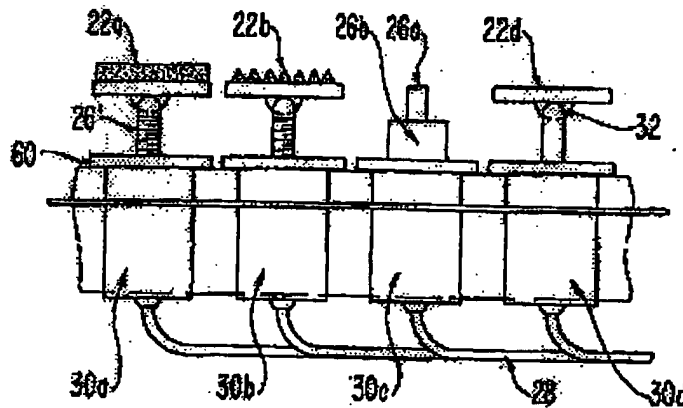
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FIG. 5**FIG. 6***Goulding, Strathby & Macdonald*



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FIG. 7

*Quincy, Smith & Associates*



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FIG. 8

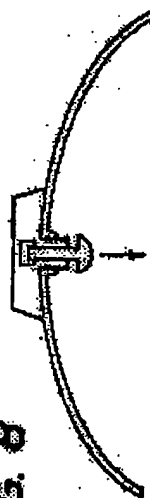
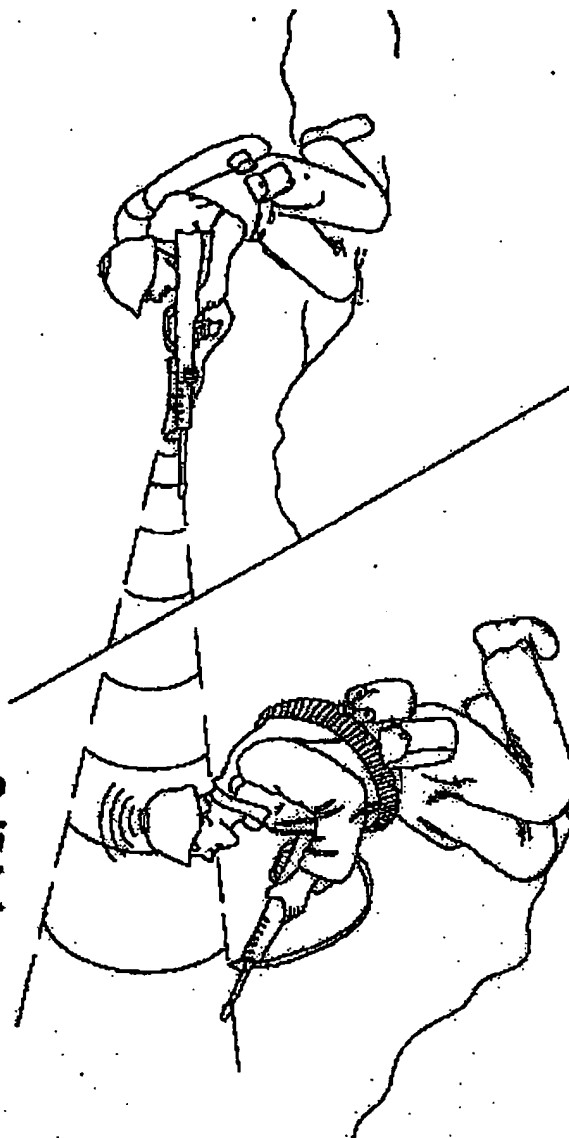


FIG. 9



Gooding, Smith & Hurler

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